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Unusual Gustiness at Cardington on the night of February 25th-26th, 1930.

By C. S. DURST, B.A.

The records obtained at Cardington with a Dines pressure-tube anemometer, the head being 150 feet above ground level, put in evidence very strikingly the different types of turbulence which are found associated with various thermal structures of the lower layers of the atmosphere. In general, super-adiabatic or adiabatic temperature gradients in the first 150 feet above the surface are associated with a large range of oscillations (both in direction and velocity) of the wind, while with an inversion the range of oscillations is small, indeed in some cases a wind of as much as eleven or twelve miles per hour has been recorded at 150 feet with no fluctuations at all.

The synoptic charts for 13h. G.M.T. on February 25th, 1930, showed that a southerly current of air with high temperature was moving over France with considerable quantities of strato-cumulus cloud. The vertical temperature gradient at Cardington on that day showed an inversion even during the early afternoon owing to the warmer air moving over ground that had previously been cooled by a prevalence of easterly winds

There was, therefore, expectation that similar temperature conditions would continue throughout the night, and that turbulence would be damped by the inversion. However, between 15h. G.M.T. and midnight the turbulence was abnormally large even though the temperature gradient still showed an inversion. This was thrown into even greater prominence by the events after midnight. Between that hour and 1h. G.M.T. the inversion

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decreased, and between 1h. 30m. and 3h. G.M.T. conditions between 150 feet and the surface were isothermal. The wind, however, showed a very marked decrease of turbulence during this period, but at 3h. the turbulence again increased when an inversion formed once again.

The association between temperature gradient and turbulence was thus exactly reversed from the normal on this occasion. There does not appear to be any very obvious explanation of this reversal from the normal, but certain facts may be noted which will probably enter into such an explanation.

In the first case, this inversion was not due to radiation but to differences in temperature between earth and air. It is, therefore, to be expected that there should be an association between higher wind speed and bigger inversion values. At the same time, the air being highly stratified, it is to be expected that the vertical variation in velocity will be greater than normal. This was so, for between 21h. and 22h. G.M.T. the speed at 150 feet was averaging 26 miles per hour, while at 50 feet it was averaging only 18 miles per hour, whereas, the normal reduction of a 26 miles per hour wind at 150 feet is 21 miles per hour at 50 feet. There thus was a tendency for the layers moving with different speeds to set up frictional eddies, but it is difficult to believe that such frictional eddies should grow to a size sufficient to give the variations shown on the anemogram.

Unusually Red Sunrises and Sunsets over the Atlantic and in the London Area.

With the introduction during the summer of 1924 of a new Ships' Code for the transmission of wireless weather reports provision was made for reporting "unusual phenomena," one of these being the occurrence of unusually red sunrises and sunsets. Six years' records being now available, and with a change taking place in the present Ships' Code on May 1st, 1930, which does not provide for the reporting of unusual phenomena, the records of unusually red sunrises and sunsets have been extracted. The observations are comprised mainly within an area situated between Lat. 41°N. and 56°N., and Long. 11°W. and 39°W. With the exceptions of August 16th, 1927, and May 8th, 1929, all the records are isolated ones, an unusually red sunrise or sunset being reported only by a single ship. On the former date, at 7h., s.s. *Montnairn* Lat. 52°N. Long. 17°W., and s.s. *Berengaria* Lat. 49°N. Long. 13°W., reported that they had previously experienced an unusually red sunrise. On the latter date, at 7h., s.s. *Montclare* Lat. 50°N.

Long. 23°W., and s.s. *Homeric* Lat. 44°N. Long. 35°W., both reported the previous occurrence of the same phenomenon. On June 23rd, 1925, s.s. *Olympic* reported both sunrise and sunset as unusually red.

TABLE 1.—ANNUAL SEASONAL DISTRIBUTION OF UNUSUALLY RED SUNRISES AND SUNSETS OVER THE ATLANTIC.

	Sunrise					Sunset				
	No.	Outward	Precipitation followed	Inward	Precipitation followed	No.	Outward	Precipitation followed	Inward	Precipitation followed
Winter										
1924-5	3	—	—	3	2	2	1	1	1	1
1925-6	0	—	—	—	—	1	—	—	1	1
1926-7	0	—	—	—	—	2	1	0	1	0
1927-8	1	1	1	—	—	3	2	1	1	0
1928-9	2	2	1	—	—	4	3	1	1	0
1929-30	5	3	3	2	1	2	—	—	2	2
Total	11	6	5	5	3	14	7	3	7	4
Summer										
1924	3	3	2	—	—	1	—	—	1	1
1925	8	2	0	6	5	2	—	—	2	0
1926	7	5	4	2	1	3	2	1	1	1
1927	8	4	1	4	3	0	-	—	—	—
1928	9	5	3	4	4	0	—	—	—	—
1929	9	1	1	8	6	2	2	2	—	—
Total	44	20	11	24	19	8	4	3	4	2

TABLE 2.—MONTHLY DISTRIBUTION.

Winter						Summer					
	Sunrise	Sunset		Sunrise	Sunset		Sunrise	Sunset		Sunrise	Sunset
Oct.	0	3	Jan.	3	2	April	5	0	July	6	1
Nov.	3	3	Feb.	0	2	May	11	0	Aug.	8	1
Dec.	2	3	Mar.	3	1	June	4	3	Sept.	10	3

Tables 1 and 2 show the annual and monthly seasonal distribution of unusually red sunrises and sunsets, reported from the Atlantic, during the period referred to above. The columns "inward" and "outward" in Table 1 indicate respectively ships on passage eastward or westward. Subsequently reported

precipitation, or the absence of same, is limited in time to the next ensuing sunrise following an unusually red one, and similarly in the case of sunset. Table 1 shows that there is a marked predominance of unusually red summer sunrises, and a very limited number of unusually red summer sunsets. In winter there is a reversal, but the contrast is not so well marked.

From Table 2 it is seen that nearly half the reported unusually red summer sunrises are distributed between the months of May and September. The subsequent percentage frequency of precipitation is highest, following an unusually red summer sunrise, with ships inward bound when it amounts to 79 per cent; outward, the frequency falls to 55 per cent. Following an unusually red winter sunrise there is a reversal; outward, the subsequent percentage frequency of precipitation reaches 83 per cent, inward 60 per cent.

From the limited number of observations of unusually red winter and summer sunsets it appears that the chance of succeeding precipitation, or its absence, is about equal, both for outward and inward ships.

TABLE 3.—ANNUAL SEASONAL DISTRIBUTION OF UNUSUALLY RED SUNRISES AND SUNSETS IN THE LONDON AREA.

	Sunrise		Sunset			Sunrise		Sunset	
Winter	No.	Precipitation before next sunset	No.	Precipitation before next sunrise	Summer	No.	Precipitation before next sunrise	No.	Precipitation before next sunset
1924-5	7	6	4	2	1924	7	4	8	5
1925-6	6	6	7	1	1925	2	2	7	1
1926-7	7	6	8	2	1926	3	1	9	3
1927-8	13	9	7	2	1927	4	3	12	5
1928-9	4	3	0	—	1928	8	5	12	5
1929-30	9	8	7	1	1929	0	—	2	1
	46	38	33	8		24	15	50	20

TABLE 4.—MONTHLY DISTRIBUTION.

Winter						Summer					
	Sun-rise	Sun-set		Sun-rise	Sun-set		Sun-rise	Sun-set		Sun-rise	Sun-set
Oct.	7	6	Jan.	10	9	April	5	7	July	3	4
Nov.	8	4	Feb.	4	6	May	2	8	Aug.	7	8
Dec.	9	4	Mar.	8	4	June	2	10	Sept.	5	13

Tables 3 and 4 contain similar records for the London area.

In contrast with the ships' observations it is seen from Table 3 that unusually red summer sunrises are most infrequent and unusually red summer sunsets most frequent. The monthly distribution, in Table 4, also differs materially. There is a pronounced winter maximum for both sunrise and sunset in January. During the summer months August shows a maximum for sunrise and June and September for sunset. Unusually red winter sunrises were followed by precipitation in 83 per cent of the cases, winter sunset in 24 per cent. For summer sunrise, precipitation followed in 64 per cent, summer sunset, 40 per cent.

TABLE 5.—SEASONAL PERCENTAGE FREQUENCIES OF THE SKY TYPES ASSOCIATED WITH UNUSUALLY RED SUNRISES AND SUNSETS.

	No.	1	2	3	4	5	6	7
		%	%	%	%	%	%	%
Winter								
Sunrise	46	11	2	4	39	24	4	16
Sunset	33	9	0	3	46	6	18	18
Summer								
Sunrise	24	21	0	0	25	33	8	13
Sunset	50	8	0	2	32	22	18	18

In Table 5 the sky types, 7 in number, expressed as a percentage frequency, associated with unusually red sunrises and sunsets are set out. There is no record of an unusually red cloudless sunrise or sunset for either season.

The numbers in this table have the following meaning attached to them :—

1 = High cloud cirrus, cirro-stratus, cirro-cumulus, singly or in combination.

2 = Middle cloud, alto-cumulus, alto-stratus, singly or in combination.

3 = Low cloud, cumulus, cumulo-nimbus, fracto-cumulus, fracto-nimbus, nimbus, strato-cumulus, stratus, singly or in combination.

4 = High, middle and low cloud, combinations of 1, 2 and 3.

5 = High and middle cloud, combinations of 1 and 2.

6 = High and low cloud, combinations of 1 and 3.

7 = Middle and low cloud, combinations of 2 and 3.

From the above classification it is apparent that unusually red sunrises and sunsets, both in winter and summer, occur most frequently with combinations of high, middle and low cloud (4). Actually, at summer sunrise, the preponderance is with a combination of high and middle cloud (5), high cloud (1) also showing a large frequency. Data, on the lines of the above, are not avail-

able from the ship's reports owing to the fact that their cloud observations refer to standard hours which do not, as a general rule, coincide with the time of either sunrise or sunset. The preponderance of unusually red summer sunrises reported from the Atlantic appears to indicate the presence of considerable amounts of high and middle cloud about this time, and, on the other hand, scarcity of unusually red sunsets favours the prevalence of much low cloud.

Assuming that unusual sky redness is an indication of the presence of moist warm equatorial air, the excess of red summer sunrises over the Atlantic may, in a measure, be attributable to this. Atmospheric pollution which may, to some extent, affect the land observations at winter sunrise and sunset, and also at summer sunset, but only slightly, if at all, at summer sunrise, cannot account for any excess of sky redness over the Atlantic.

On March 31st, 1930, s.s. *Caronia* Lat. 50°N. Long. 17°W. reported an unusually red sunrise; the phenomenon also occurred in the London area on the same date, and is the sole occasion during the period of similarity in the observations. Although the effects were the same the causes were different, as the pressure distribution for the day shows.

The term unusually red sunrise or sunset, as used for the London area, indicates sky and cloud in the east at sunrise, and the west at sunset as (1) unusually all red, or (2) unusually red. In the former, red or gradations of red are the sole composition, and in the latter gradations of red are predominant, but some other colour enters into the composition. The intensity of the red coloration, in both cases, determines whether the description " unusually " is applicable.

SPENCER RUSSELL.

Heavy Rainfall Near Whitby, July 20th—23rd, 1930

The striking feature of the rainfall which caused the serious floods in the valley of the River Esk, was its persistence. The amounts were large on each of the four days, July 20th-23rd, and increased fairly steadily up the valley especially on the 22nd, when over five inches was recorded. The rainfall records set out below have been kindly supplied by observers in the Esk Valley. The stations are arranged in order up the Valley :—

	July, 1930				Total
	20th	21st	22nd	23rd	20th-23rd
	in.	in.	in.	in.	in.
Whitley (Westhorpe)	2·27	1·47	1·28	·12	5·14
Aislaby (Park Hall)	2·60	2·46	3·11	·31	8·48
Sleights (The Hall)	2·48	2·44	3·01	·38	8·31
Egton Bridge (Bridgeholme) ...	2·44	2·62	4·07	·65	9·78
Glaisdale (The Gables)	2·17	2·24	3·68	·24	8·33
Danby School	2·46	2·25	5·20	1·13	11·04
Castleton	2·70	2·32	5·70	1·25	11·97

The amounts cover the 24 hours commencing at 9 a.m. G.M.T. on the day of entry.

Much smaller rainfall amounts were recorded to the south of the Esk Valley. At Pickering and Helmsley, some 10 miles to the south, the totals for July 20th-23rd were only 2·14in. and 1·80in. respectively. To the north and more especially the west the rainfall gradient was less steep. At Lockwood Reservoir, to the north of Castleton the amounts were 2·70in., 1·84in., 4·46in. and 1·11in., a total of 10·11in. At Kildale Hall, just to the west of the Esk Valley, the amounts were 2·28in., 2·03in., 4·55in. and 1·18in., a total of 10·04in. At Nunthorpe and Crathorne, further west, the totals were 4·70in. and 3·99in. respectively. Much damage by flooding also occurred therefore in the Leven Valley. In the Sleights to Castleton area the rain appears to have started about 15h. on the 20th and continued with but few breaks until noon on the 23rd. There was a definite break of a few hours on the evening of the 21st. At Sleights the observer notes that there was "never anything more than what I should call heavy rain," while at Danby School the rain of the 22nd is described as "incessant." The observers comment on the steadiness of the rain and the absence of intense falls.

It is reasonable to conclude from the table above that the rainfall of both the 20th and 21st exceeded two inches practically everywhere in the Esk Valley, while that of the 22nd exceeded four inches over most of the upper half of the valley. Few streams could be expected to cope with the widespread fall of over eight inches in three days without serious flooding. The highest flood occurred early on the 23rd, following the heavy rainfall on the 22nd on ground already saturated by the rain of the two previous days. The Egton and Sleights bridges gave way about 5h. on the 23rd. Subsequently the level of the river fell rapidly. The most severe flooding naturally occurred in the lower Esk Valley, notably between Sleights and Whitby. An unprecedented feature was the use of the Whitby lifeboat at Ruswarp, two miles inland, where it was launched from its carriage over flooded fields for rescue work. The bridge at Sleights carried two water mains to supply Whitby, and these were severed when the bridge broke, reducing the town to 48 hours' supply. The supply was restored, however, with the aid of the Royal Engineers from Catterick Camp.

The heavy rain was due to a depression which persisted off the east coast of Lincolnshire from the morning of the 21st to the 24th and maintained strong northerly winds over the north Yorkshire Wolds. The distribution of the rainfall was controlled to a large extent by the configuration of the land, the largest amounts occurring over the more elevated parts of the moors and the least rainfall immediately to the south.

J. Glasspoole.

Official Notice

Course of Training for Observers

It is proposed to hold a course of training for observers at climatological stations on Monday and Tuesday, September 23rd and 24th, 1930, at Kew Observatory, Richmond.

Subject to limitations of space at the Observatory, the course will be open to all climatological observers in connexion with the Meteorological Office. There will be no fee.

Admission to the course will be by ticket, which may be obtained on application to the Director, Meteorological Office (M.O.7), Air Ministry, Kingsway, London, W.C.2, from whom further information regarding the course may also be obtained.

Official Publication

The following publication has recently been issued.

The Weather Map. An introduction to modern meteorology. 2nd edition. (M.O. 225i.)

In view of the wide interest taken in weather forecasts and maps, the Meteorological Office have just issued a new edition of their publication "The Weather Map," which first appeared 15 years ago, and since that time has had a large sale. The new edition, which has been completely rewritten and consists of 83 octavo pages together with a number of maps, commences with a short historical summary describing the progress made from the year 1688, when the first-known weather map was published, down to the present date. The method of constructing a modern daily weather map is then described in detail, reference being also made to the method of taking the observations. Chapters follow on the weather associated with depressions and other pressure systems, and on modern methods of forecasting, while the book concludes with a discussion of some typical forecasts for the British Isles. It should appeal to a wide public.

Correspondence

To the Editor, *The Meteorological Magazine*

Dry Junes

There is no doubt that June is becoming an increasingly dry month. The total rainfall of the last 12 Junes was more than 7in. less than that of the 12 preceding Junes, 1906-18. The June average at the end of 12 years' readings here (1906-18) was 2·29in.; at the end of 24 years (1906-30) it is only 1·99in. In 1925 it provided the only absolutely rainless month in 36 years' observations, the last 24 being at this station. This year May and June have only yielded 1·86in. compared with 5·54in. last year in the dry January-September spell, but the January-June

fall this year is still above the normal. The increasing dryness of June is proving disastrous to field and garden.

R. P. DANSEY.

Kentchurch Rectory, Hereford. July 7th, 1930.

Halos at Kashgar

By courtesy of Mr. A. Nimmo we have received a description and sketch of a system of solar halos observed by his nephew, Mr. G. Sherriff, at Kashgar, in Eastern Turkestan, on April 26th, 1930, from 7h. to 8h. The system consisted of the halos of 22° and 46°, each surmounted by a small tangent arc, the lower one subtending an angle of about 10°, the higher one about 30°. The halos showed faint prismatic colours, which were stronger at the contact of the 22° halo with its tangent arc. The air was hazy and in the haze two luminous uncoloured patches appeared just outside the 22° halo on either side of and at the same height as the sun; these " mock suns " were also marked by brighter patches on the halo.

Evaporation from Raingauges

The article by Mr. A. J. Bamford in the *Meteorological Magazine* for May, 1930 (pp. 82-87), and particularly his remarks (pp. 83-84) on the evaporation of water from a self-recording raingauge call to mind a case experienced at Amman, Trans-jordan, in the early autumn of 1929.

Hyetographs in the Middle East Area are withdrawn from use and stored during the dry season : in September when the instrument was put into action again with a little water in it, it was found that the pen traces became lower every day and on some records dropped about half a millimetre of chart scale in twenty-four hours. Leakage in the copper container and/or float was suspected, but examination showed none, so careful tests were made. The container was detached, almost completely filled with water so as to give good pressure on the base and side seams, it was then kept under observation whilst standing on a pad of clean blotting paper which would have shown up any drops exuding from the base; the seam down the side showed no sign of leaking. The float was immersed in hot water and watched for air bubbles, none was seen, nor did any water find its way into the float when it was allowed to cool while still submerged.

These tests having revealed no leakage it was assumed that evaporation could have been the only explanation since no other instrumental faults were discovered. The hyetograph was re-assembled with a small amount of water in it to bring the pen up to its correct position and a small quantity of paraffin was floated on the top of the water in the annular space surrounding the float : this appeared to give a complete cure of the trouble.

The Amman daily rate of evaporation was nearly equal to

Mr. Bamford's rate for a fortnight: assuming his observations were made near Colombo, the lower humidity and greater height (about 2,600ft. above M.S.L.) of Amman may have been the causes and, perhaps, duration of sunshine may be included since Amman appears to be less cloudy than Colombo; the maximum temperatures for both places are roughly comparable, but Colombo minima are higher.

The self-recording gauge at Amman was the ordinary Negretti & Zambra hyetograph of the type in common use by the Meteorological Office: it rested on a concrete slab, about eighteen inches square, which surrounded the open end of a buried drain pipe into which depended the copper container: the air around the latter changed slowly of course. The ground all round the gauge was hard baked with a dusty surface and reddish-brown in colour, bare but for very sparse camel thorn: in wet weather it becomes almost clay-like "sticky" mud—about half an inch of rain in twelve hours gives an almost water-logged state: it seems likely that the heat of the ground around the container may have played a part in aiding evaporation. The collecting funnel, cylinder and combined case for the working parts, with the cast-iron base on which they were mounted, formed a heavy mass of metal of large heat content: although coated with aluminium paint they became almost uncomfortably hot to the touch. Heat conductivity between the upper exposed parts and the underground container must have been slow since they were joined by but three small brass lugs and screws, apart from the float stem in light contact with its guide; it would be a simple matter to fit bolts and nuts passing through insulating bushes and washers which would reduce heat transference.

It is suggested that the heat absorption of all gauges could be reduced by a high polish—the maintenance of which would be one of the few jobs of work well done and enjoyed by cheap native labour, though maybe the glitter would attract thieves. Chromium plating would cut down the work of polishing to an occasional wiping with a damp cloth.

C. VAUGHAN STARR.

R.A.F. Station. Biggin Hill, Kent. June 23rd, 1930.

NOTES AND QUERIES

Raingauges in Frosty Weather

Writing with reference to Mr. Bilham's article in the *Meteorological Magazine* for December, 1929, on the protection of raingauges from damage in frosty weather Mr. Rakhahari Bakshi of Alipore Observatory has sent some notes in which he attacks the popular belief that water when freezing bursts the wall of the vessel by mass action.

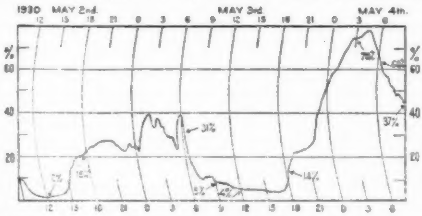
Last year while working on secondary radiation in ice at

different temperatures Mr. Bakshi had to prepare pure dust-free ice by freezing distilled water in evacuated bulbs. It was noticed that in the course of freezing a crust was first formed on the top of the water. The crust was always of hard ice, irregular underneath and about 5mm. thick. The water below the crust froze after a long time into a mass of beautifully transparent ice. Apparently in the course of freezing pressure is exerted on the glass wall as well as on the ice-coating. The adhesion between the glass wall and the ice-coating is sufficient to prevent the forcing up of the ice-coating. The glass wall can withstand a uniform pressure. The result is the "fracture" of the ice-coating—through which the expanded mass oozes up. The fracture of the ice-coating is always accompanied by great noise—the crust being left furrowed in consequence.

The cracks always occur just below the upper crust and usually have the appearance of the centre of a spider's web with many radiating lines about 5mm. in length. Cracks sometimes appear spontaneously after a long interval, even after a lapse of twenty hours. A direct proof that the cracks are due to the action of crystals is not possible, but the characteristic starlike forms can only be due to point pressure. A great internal pressure would rather break the glass into fragments. As the cracks occur in the zone where small crystals of ice are seen to grow it is likely that it is the pressure of crystals bearing on the ice that produces the cracks. The questions raised by Mr. Bakshi are of great interest and it is to be hoped that they will receive further examination.

The Accuracy of a Hair Hygrograph

We have received from Capt. J. Durward a copy of a record obtained at Heliopolis, Egypt, with a hair hygrograph. On the record he has written the corresponding values of relative humidity (per cent.) calculated from the readings of the wet- and dry-bulb thermometers. The agreement, as will be seen from the illustration, is remarkably close, in spite of the large range of humidity from 2 per cent to 78 per cent, and it will be admitted that the comparison reflects credit on the observers for their management of the instruments as well as on the accuracy of the hair hygrograph. Capt. Durward remarks that the figure of 2 per cent is the lowest relative humidity ever measured at Heliopolis.



A "Record" Gust

In a recent search for information about extreme wind speeds in the valleys of mountainous districts, I was interested to come upon a note of a gust apparently exceeding any of the well-known "record" gusts of the British Isles. During the period October, 1901, to February, 1902, Mr. R. C. Mossman made a series of observations at Achariach in Glen Nevis some $4\frac{1}{4}$ miles (in a direct line) to the south-east of Fort William: "it would hardly have been possible to have had a station more admirably placed for the study of valley conditions."* The more local surroundings of the observing site (150 feet above M.S.L.) were open, but the station was shut in, except along the narrow valley to northwestward, by high mountains with peaks ranging from 3,000 to 4,400 feet in height, within distances of $1\frac{1}{4}$ to 2 miles. For part of the time readings were made from the Dines Pressure Tube Anemometer of the type registering (*a*) velocity at the moment of reading; (*b*) the mean velocity, and (*c*) the maximum gust since last observation, the last registration being by means of a metal index. According to Mr. Mossman's description, "The feature of the wind is its gustiness, and these gusts are separated by long intervals of calm, or very light airs. The highest velocity recorded was 117 miles per hour on the morning of February 27th, at which time a full gale reaching force 10 at some hours was blowing from the south-east on Ben Nevis. The gale was severely felt in the Glen, and considerable damage was done at Glen Nevis House, where some buildings that had stood for twenty years were demolished about 8 a.m. The strength of the wind was found to vary greatly in different parts of the Glen, being greatest at such places as the Garochar and at the highest point of the carriage drive near Allt Eoghain, where a steady wind of force 8 to 9 was experienced. The highest mean velocity shown by the Dines anemometer for this day was 37 miles per hour from 10 a.m. to noon." I wrote to Mr. Mossman, who is now in Argentina, asking for further information regarding these observations; he very kindly gave me the particulars above quoted about the type of instrument in use, and added: "I do not think you should include this gust in an official list, because although the anchorage was very good the pole may have vibrated and vitiated the record. Further, on the barograph trace there is no record of unusual pumping. The squall was certainly a very severe one, as some wooden outbuildings at Glen Nevis House which had stood for about 20 years were blown down and carried across an adjacent meadow. I remember when I made the reading I was astonished at the high value recorded." In view of Mr. Mossman's remarks it is hardly felt that the gust could be claimed as the record in preference to certain other gusts of speeds ranging up to

* *Edinburgh, Proc. R. Soc. XLIV*, p. 633 *et seq.*

112 m.p.h., which in later years have been recorded on the anemographs from Dines pressure tube instruments. But at the same time the Glen Nevis gust and other general features of the Glen Nevis records demonstrate that however much the shelter of mountains may reduce the mean wind speed in the valleys the risk at least remains of the occurrence once in a while of a gust of practically the same order of force as those experienced in the most exposed places.

A. H. R. GOLDIE.

An Upper Air Temperature Indicator for Use with Pilot Balloons

In a recent paper* Mr. G. Chatterjee has described a temperature indicator for use with pilot balloons which has been successfully developed by the India Meteorological Department. The customary methods of obtaining upper-air temperatures by aeroplane or sounding balloon are expensive and in the latter case the readings are not available until some days or weeks after the ascent, rendering the method unsuitable for use in forecasting. The need for an indicator which will give the height at which some particular upper-air temperature is reached by a pilot balloon has often been felt and the method described by Mr. Chatterjee in detail appears to have met the need, at any rate so far as India is concerned. The instrument, which weighs 40 grams complete, consists of a simple bimetallic thermometer, shaped somewhat like an inverted letter U, the arms of which, as they separate, release a paper disc at a predetermined temperature. The paper disc carries a small tube of sulphuric acid which falls into a tray containing a mixture of potassium chlorate and sugar. The resulting combustion causes a puff of smoke which can be observed through a theodolite and also burns a string which releases the instrument with a flag from the balloon. This release is also observed. The tail method of observation enables the height of the balloon at the moment of release to be calculated. The temperature at which release takes place is determined by the size of the paper disc and these discs are made in various sizes, one being chosen in accordance with the particular temperature which it is desired to indicate. The height-temperature data which have been obtained in India by the method are stated to agree within 1°C. with those obtained by the Dines meteorograph.

It does not appear that any steps are taken to recover the instrument when it falls, and if used in this country the expense of the method would be by no means negligible. Probably this type of instrument can be made a good deal more

*An upper air temperature indicator for use with pilot balloon, by C. Chatterjee, *Gerlands Beiträge zur Geophysik*, Vol. [illegible]4 (1929), pp. 343-52.

cheaply in India, and the success obtained in a large number of ascents made at selected observatories in India appears to have fully justified the method.

Medical Climatology in Austria

The Bureau of Public Health in the Ministry of Social Administration, Vienna, sends us a series of reports, reprinted from the official journal "Mitteilungen des Volksgesundheitsamtes," in which the activities of this service are described. A number of stations have been established at levels up to 5,000 feet, furnished with autographic instruments for recording sunshine, temperature and humidity, rain- and snow-gauges, anemometer and also a katathermometer, wedge photometer and scale for measuring the blue of the sky. The investigations are specially directed towards the establishment of health resorts, especially sanatoria for tuberculosis.

The reports hitherto received include an introductory statement of the programme by Dr. V. Conrad, a report on a year of climatic observations in Gargellen (Montafon) a report on the climate of Grafenhof-St. Veit (Salzburg), a paper on the rate of cooling in the rest-room of the curative station for consumptives at Grafenhof and the temperature sensations of the patients (in which observations with the katathermometer were largely used), a report on the climatic observations on the Muttersberge, near Bludenz, in Vorarlberg, measurements of radiation on Semmering, measurements of water temperature in public bathing places in lakes in the Austrian Alps, and a brief preliminary account of methods of investigation into the physical and chemical characteristics of mud-baths.

Reviews

The Climate of the Netherlands. C. Air pressure, D. Wind. By Dr. C. Braak. K. Ned. Meteor. Inst. No. 102. Med. en Verh. 32. Size 9½in. × 6¾in., pp. 117 (Dutch) + 41 (English Summary). *Illus.* Batavia, 1929.

The preparation of a handbook on the climate of the Netherlands, by the Royal Meteorological Institute of De Bilt, began several years ago. In 1913 appeared the section on rainfall and in 1920 that on temperature; these were under the authorship of Dr. Hartman, and included translations in French. The present section on air pressure and wind is by Dr. C. Braak and includes a summary, rather than a full translation, in English, but it seems likely that no information of importance has been omitted.

Average values of pressure at five stations are given, based on observations since 1901, the year when accurate standardisa-

tion of barometers began. The figures for diurnal variation are mostly based on shorter periods, while for absolute extreme values of pressure a series of combined observations, at Utrecht and De Bilt since 1848, is used. Examination of the tracks frequented by depressions in Holland and neighbouring regions leads to a modification of the results usually quoted on the authority of van Bebber, as for instance in Hann-Süring's *Lehrbuch*.

The annual and diurnal variations of wind velocity and direction are very fully discussed, with tables and diagrams. A table is included showing averages of wind velocity reduced to a level of 6 metres above ground. In the case of De Bilt, for instance, winds of force 5 and 6 at the 20-metre level are reduced to the 6-metre level by subtracting 15 per cent. The reduction factors are based on the work of Hellmann, Dines and others, but how far results obtained near Berlin, say, may be taken as valid for stations near the coast of Holland is open to argument, as is indeed admitted in the text. The uncorrected figures being given, however, the reader may use which he pleases. The remainder of the English text is devoted to descriptions of some noteworthy gales and a note on whirlwinds, it being stated that during the period 1888-1913 Holland experienced whirlwinds of more or less importance on an average of 8 days a year. This work forms a valuable discussion of pressure and winds in Holland. Several previous reviews in this magazine have complimented Dr. Braak on his command of the English language; in this case he again deserves the thanks of all those English-speaking meteorologists who have not an equivalent knowledge of the Dutch language.

S. T. A. MIRRLEES.

La Mécanique Différentielle des Fronts et du Champ isallobarique. Par Antonio Gião. Mémorial de l'Office National Météor de France, No. 20, *Paris,* 1929.

The author of this work has for some years made a study of methods of forecasting practised in different Continental countries. In France special attention is paid to pressure changes, shown by isallobars, while in Norway the chief emphasis is on the discontinuities, or "fronts," separating different air masses. The memoir under review aims at a synthesis of the two methods, by means of an analytical discussion of the changes of pressure in relation to the fronts. General Delcambre, the Director of the French Meteorological Office, contributes a preface, and this is followed by a short introduction by Dr. J. Bjerknes. Both writers speak in terms of high praise of M. Gião's work.

The memoir is worth the attention of those who wish to increase

their familiarity with the theoretical aspects of fronts, and with the type of analysis involved. The style is very clear, and the analysis quite straightforward, but nevertheless a shorter work would have appealed to a larger number of readers. It is useful to have a mathematical discussion of this subject, but, as in almost every branch of meteorology, the complete mathematical expressions are complex, and simplifications have to be introduced. In a paper containing some hundreds of equations it is not always easy to know on what assumptions any particular formula is based.

The initial line of attack is the consideration of two adjacent infinitesimal elements, one on each side of an idealised surface of discontinuity, at a particular instant. These elements have equal pressures and equal components of velocity and acceleration normal to the surface of discontinuity, although they are moving on different tracks, with different components of velocity and acceleration in other directions. From these facts and from the equations of notion, it is possible to deduce various relationships. From p. 39 onwards, most of the formulæ are expressed as far as possible in terms of the pressure and its changes, since this is the variable which can be observed most accurately, and which is least dependent on purely local and superficial effects. The fundamental relations are derived by a method similar to that mentioned above, but for the most part in two dimensions only. The front is taken at right angles to the x-axis, and we have the equation—

$$\left(\frac{\delta p}{\delta t}\right)_f = \frac{\delta p_1}{\delta t} + u_f \frac{\delta p_1}{\delta x} = \frac{\delta p_2}{\delta t} + u_f \frac{\delta p_2}{\delta x}$$

The left-hand term gives the change of pressure on either element, moving along with the front with velocity u_f, while the suffixes 1 and 2 refer to the separate elements. For simplicity we may consider a V-shaped trough with the isobars on each side making an acute angle with the front. Then the element in advance of the front is moving towards higher pressure, and the term $u_f \frac{\delta p}{\delta x}$ is positive, whereas the corresponding term for the element in the rear is negative. The terms $\frac{\delta p}{\delta t}$ are of course always different on the two sides, and in the special case when the pressure at the moving front is not changing, they cancel out the others. If we ignore details of structure, which do not enter into the idealised front, the motion u_f does not in general correspond with that of any element of air, so that it is difficult to attach a physical meaning to the different terms. The equations admit of considerable development in terms of the pressure gradients and their changes and of the fields of isallobars. Somewhat similar methods are adopted in the case of temperature distribu-

tion, and the sharpening or smoothing out of fronts. The adiabatic relation between pressure and temperature is considered in detail.

The more complex equations are simplified by rejecting the smaller terms. Hesselberg and Friedmann's figures for the order of magnitude of the different terms are used more than once. On p. 25 a six term expression for the acceleration of the front is much simplified for the earth's surface by assuming that the vertical velocity is zero, and the same assumption is sometimes made later on. The assumption is not in general justifiable when applied to a front, as it ignores the convergence to the front. Later in the paper it is shown from anemograms that the difference between the wind components normal to the front on the two sides is small. This one would expect, since the component of pressure gradient is the same, but unfortunately the small difference is important for the problems considered in this memoir.

The equations are of course based on infinitesimals, but they can be adapted to actual weather maps by the introduction of approximate methods based on finite differences. Dr. Bjerknes, in his introduction, states that some of the formulæ led to successful 12-hour forecasts at Bergen. Further developments will be awaited with interest.

From the examples given by M. Gião, it is by no means self-evident that the use of the formulæ would lead to an improvement on the methods now in use, which really consist of extrapolations from the previous movements of the front, and from the changes of pressure and of gradients. Roughly speaking, present methods deal with phenomena *in toto*. Whether analytical methods would give better results is likely to depend on how far the separate terms obtained in the analysis correspond with physical realities.

In the final chapter the author discusses the forecasting problem and expresses the opinion that the study of fronts and of air masses on the earth's surface provides the most hopeful line of advance. He considers that in spite of surface friction the conditions at the ground are less complex than those up aloft, the main reason being the absence of vertical motion. The reviewer cannot agree with this opinion. The primary units of atmospheric circulation, the cyclone and the anticyclone, seem to present three-dimensional problems, insoluble from a consideration of surface conditions alone.

C. K. M. Douglas.

Books Received

Man and his climatic environment in the Tropics. By Prof. R. de C. Ward.

The acclimatization of the white race in the Tropics. By Prof. R. de C. Ward.

Résumés mensuels et annuels des Observations Météorologiques faites aux stations de 11 *ordre du Réseau de l'Observatoire Geophysique á l'Oriente Lointain.* Année 1919. Fascicule III. Vladivostok, 1929.

Some of the Work of the Geophysical branch of the Solovetski Society for local observations, by A. G. Sanin (in Russian). Solovetsk Islands, 1929.

Deutsches Meteorologisches Jahrbuch, 1928, Freie Hansestadt Bremen. Edited by Dr. A. Mey, Jahrgang xxxix, Bremen, 1929.

Obituary

Father José Algué, S.J.—Born at Barcelona on December 28th, 1856, José Algué began his studies at the Colegio de San Ignacio and early came under the influence of the Rev. Don José Faura, brother of the founder and first Director of the Observatory of Manila in the Philippine Islands. His interests took a scientific turn, including mathematics, physics and chemistry, and in 1889 he was selected by the superiors of the Compañia de Jesús to collaborate in the work of the Observatory. In 1891 he visited the United States to study astronomy and in 1893 he took an active part, on behalf of Spain and the Philippines, at the International Meteorological Congress which met at Chicago. Ater this Congress he returned to Spain, and thence proceeded to Manila as Assistant Director of the Observatory under Father F. Faura.

The year 1894 was remarkable for an extraordinary number of typhoons, and Father Algué immediately commenced the study which became his chief work. His first essay appeared in 1895, followed in 1897 by "Baguios o ciclones filipinos" and "El Barociclonómetro." The same year, on the death of Father Faura, he became Director of the Observatory. In 1904 followed his famous monograph "Cyclones of the Far East," indispensable for all subsequent studies of the phenomena of tropical cyclones. This work was written in English but has been translated into several other languages. Other meteorological work was not neglected, however; as early as 1898 he published a paper on "The clouds of the Philippine Archipelago." The network of stations and the meteorological service of the Philippines was continually expanded, including the erection in 1907 of the high-level observatory of Mirador, at a height of 1,512 metres, and Father Algué was a regular attendant at the International Meteorological Conferences. In 1906 he was elected an Honorary Member of the Royal Meteorological Society, and he has made three contributions to the pages of the *Quarterly Journal.* In 1924 he again visited Europe

to organise the Philippine exhibit at the Vatican missionary exhibition of 1925, and then ill-health made it impossible for him to return to Manila. He died at Roquetas on May 27th, 1930.

News in Brief

According to a note from the Norddeutscher Lloyd in the *Meteorologische Zeitschrift* for May, 1930, so-called pilot balloon stations have been instituted on some German liners from which, weather permitting, one or more balloons are sent up daily. One of these vessels is the *Sierra Morena*, on which observations up to 16,000m. have already been made.

Erratum

July, 1930, p. 133, line 4, for "49°F. at 1h." *read* "39°F. at 1h."

The Weather of July, 1930

The most noteworthy features of the month were the prolonged period with day temperatures below normal, the heavy rainfall in parts of England and south Scotland and the excessive number of days on which thunderstorms occurred. An indefinite ridge of relatively high pressure across England with a stationary depression to the northwest gave warm sunny weather generally in England for the first week though slight rain occurred locally. In Scotland and Ireland the weather was more unsettled with showers and bright intervals. Heavy rain, however, fell at a few places on the 2nd-4th, including 1·68in. at Rathnew, Co. Wicklow on the 3rd. Thunderstorms occurred in Scotland and north England on the 1st-4th and in eastern England on the 1st. Temperature was high during this time reaching 79°F. at Hull on the 2nd, 81°F. at Tottenham on the 5th, 82°F. at Norwich on the 6th and 80°F. at Southampton on the 9th. The depression centred near Iceland moved southeastward on the 9th and with northerly winds over the British Isles, temperature fell markedly that evening. The weather continued sunny in the north and west for a day or two but much cloud and local severe thunderstorms were experienced in the east and south on the 10th and 11th. The 5th, 6th and 7th were the sunniest days of the month in south England and the 11th and 12th in north England and Scotland, 15·1hrs. of bright sunshine occurring at Oxford on the 5th, at Hastings on the 6th and at Rothesay on the 11th. Subsequently with depressions moving slowly and erratically across the country, the weather became unsettled and cool, with a general deficiency of sunshine. Except for the 13th, day temperatures remained generally below normal to the end of the month. The 22nd and 23rd were the coldest days, many places in the Midlands reporting maxima of only 51°F. Rain fell on most days

between the 12th and 31st with frequent thunderstorms but there were many long bright periods between. The sunniest days were the 17th, 19th, 25th, 27th and 31st, 14·9hrs. occurred at Deerness on the 25th, 14·4hrs. at Shoeburyness on the 27th and 12·0hrs. at Collumpton on the 19th and at Bath on the 31st. Thunderstorms were most widespread over Great Britain on the 29th and 30th. The rainfall amounts were generally small, except for isolated falls (2·00in. fell at Lincomb Lock, Worcester, on the 13th, 2·89in. at Castle Caulfield, Co. Tyrone, on the 16th and 2·0in. at Berwick-on-Tweed on the 17th), and for the extremely heavy falls which occurred over the area extending from Norfolk and Brecon to Aspatria and Durham from the 20th to 23rd. The heaviest and most continuous rain of this period fell in the North Riding, Yorkshire, where there was severe flooding.* Except for Aberdeenshire, the London area and parts of Cornwall the total rainfall for the month was above normal. The distribution of sunshine was as follows—

	(hrs.)	(hrs.)		(hrs.)	(hrs.)
Lerwick	111	— 41	Liverpool	146	—47
Aberdeen	157	— 2	Ross-on-Wye	177	—22
Dublin	128	— 42	Falmouth	231	+ 6
Birr Castle	94	— 50	Gorleston	177	—54
Valentia	119	— 40	Kew	173	—28

Pressure was below normal over western Europe (except the Iberian Peninsula) and the Azores, the greatest deficits being 6·3mb. at Brest and 6·1mb. at The Helder, while pressure was above normal over Spitsbergen, northern Iceland, the Iberian Peninsula and most of the North Atlantic, the greatest excess being 3·8mb. at Jan Mayen. Temperature was above normal in Spitsbergen, Scandinavia and Portugal and below normal in central Europe, while rainfall was deficient in Spitsbergen and northern Scandinavia and in excess in southern Scandinavia and central Europe. The total rainfall was about twice the normal in south Scania and Dalsland but only 60 per cent of the normal in Norrland.

Thunderstorms were experienced in Belgium on the 1st and a hailstorm ruined most of the grape crop in the Vauvray district of France on the 2nd. Warm weather was experienced in Hungary early in the month. On the 6th a waterspout occurred between Lausanne and Vevey and torrential rain, accompanied by gales fell over Switzerland on the 11th and 12th causing floods. On the 13th there was heavy snow in Switzerland with a considerable drop in temperature. Great heat was experienced throughout Portugal about the 15th. A forest fire broke out between Saint Raphael and Valescure on the 15th, but was extinguished the following day. Heavy rain caused damage to crops again in Switzerland about the 25th. The Rhone and the Arve were both rising rapidly and floods

*See p. 158.

were reported from Haute Savoie and Canton Ticino. A cyclone swept over Adrianople on the 26th causing loss of life and material damage.

A severe typhoon swept across Kiushiu, the southernmost island of Japan, and northwards along the eastern coasts of Korea on the 18th. Over 400 people were killed, mainly in Korea, and great material damage was done both on the sea and land. Severe floods occurred on the Indus, near Shikarpura and Larkana on the 25th. The flood water was diverted from the towns then, but heavy rain continued for some days and by the 31st the situation was much worse. Shikarpura was nearly surrounded by deep water, and water from the hilly Baluchistan tracts was coursing through Jacobabad. The villages of Jhatpat and Mamal were submerged and the thousands of refugees from Shikarpura, Sultankot and Khanpur were in peril.

The South Australian drought was broken by a fall of between 1 and 2in. of rain between the 1st and 3rd. Further general rains in South Australia towards the end of the month greatly benefited the wheat and pastoral lands.

Hail caused much damage to the crops in the Prairie Provinces, Canada, about the 11th and again in Saskatchewan on the 17th. Warm wather was experienced in British Columbia early in the month. A severe thunderstorm occurred in New York on the 3rd. Temperature was above normal in the west of the United States during the first week of the month and this heat spread to the east for the rest of the month. During the heat wave 106°F. was recorded at Washington, D.C., on the 20th and 98°F. at New York on the 21st. After this there was a slight fall in temperature but it still remained above normal. Rainfall was generally deficient. Rather cool dry weather prevailed generally in the Argentine during the first three weeks of the month.

The special message from Brazil states that the rainfall in the northern and central regions was scarce with averages 1·57in. and 0·47in. below normal respectively, while in the southern regions the distribution was irregular with an average almost normal. Four large anticyclones passed across the country. Gales were experienced along the coast southwards from Cabo Frio. Crops were generally affected by the lack of rain and the vegetables in the south harmed by the frost. At Rio de Janeiro pressure was 1·6mb. below normal and temperature 1·6°F. above normal.

Rainfall, July, 1930.—General Distribution

England and Wales	143	per cent of the average 1881-1915.
Scotland	95	
Ireland	113	
British Isles	124	

Rainfall: July, 1930: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Lond	Camden Square	2·00	84	*Leics*	Belvoir Castle	3·20	132
Sur	Reigate, Alvington	2·89	128	*Rut*	Ridlington	3·09	...
Kent	Tenterden, Ashenden	3·36	161	*Linc*	Boston, Skirbeck	2·46	112
,,	Folkestone, Boro. San.	2·35	...	,,	Cranwell Aerodrome	3·58	153
,,	Margate, Cliftonville	2·10	106	,,	Skegness, Marine Gdns	4·41	203
,,	Sevenoaks, Speldhurst	2·43	...	,,	Louth, Westgate	5·35	214
Sus	Patching Farm	2·34	97	,,	Brigg, Wrawby St.	5·50	...
,,	Brighton, Old Steyne	2·30	106	*Notts*	Worksop, Hodsock	5·92	260
,,	Heathfield, Barklye	3·42	137	*Derby*	Derby, L. M. & S. Rly.	5·79	240
Hants	Ventnor, Roy. Nat. Hos.	1·56	77	,,	Buxton, Devon Hos.	6·91	176
,,	Fordingbridge, Oaklnds	2·18	109	*Ches*	Runcorn, Weston Pt.	5·18	188
,,	Ovington Rectory	2·26	88	,,	Nantwich, Dorfold Hall	7·02	...
,,	Sherborne St. John	1·69	76	*Lancs*	Manchester, Whit. Pk.	...	...
Berks	Wellington College	2·56	124	,,	Stonyhurst College	5·99	155
,,	Newbury, Greenham	2·34	106	,,	Southport, Hesketh Pk	3·46	121
Herts	Welwyn Garden City	2·88	...	,,	Lancaster, Strathspey	3·30	...
Bucks	High Wycombe	3·02	153	*Yorks*	Wath-upon-Dearne	5·65	225
Oxf	Oxford, Mag. College	2·86	127	,,	Bradford, Lister Pk.	5·81	211
Nor	Pitsford, Sedgebrook	2·88	122	,,	Oughtershaw Hall	6·18	...
,,	Oundle	1·90	...	,,	Wetherby, Ribston H.	5·28	211
Beds	Woburn, Crawley Mill	2·43	109	,,	Hull, Pearson Park	4·70	201
Cam	Cambridge, Bot. Gdns.	3·06	142	,,	Holme-on-Spalding	4·79	...
Essex	Chelmsford, County Lab	2·72	128	,,	West Witton, Ivy Ho.	4·04	...
,,	Lexden Hill House	3·67	...	,,	Felixkirk, Mt. St. John	6·89	252
Suff	Hawkedon Rectory	4·54	186	,,	Pickering, Hungate	4·02	...
,,	Haughley House	3·69	...	,,	Scarborough	5·63	231
Norf	Norwich, Eaton	...	...	,,	Middlesbrough	4·89	191
,,	Wells, Holkham Hall	...	...	,,	Baldersdale, Hury Res.	5·03	...
,,	Little Dunham	5·42	197	*Durh*	Ushaw College	5·79	207
Wilts	Devizes, Highclere	2·11	91	*Nor*	Newcastle, Town Moor	3·99	151
,,	Bishops Cannings	3·17	127	,,	Bellingham, Highgreen	6·28	...
Dor	Evershot, Melbury Ho.	3·06	121	,,	Lilburn Tower Gdns.	6·83	...
,,	Creech Grange	1·89	...	*Cumb*	Geltsdale	7·63	...
,,	Shaftesbury, Abbey Ho.	1·56	61	,,	Carlisle, Scaleby Hall	6·32	193
Devon	Plymouth, The Hoe	2·08	75	,,	Borrowdale, Seathwaite	6·10	72
,,	Polapit Tamar	2·39	89	,,	Borrowdale, Rosthwaite	...	...
,,	Ashburton, Druid Ho.	2·96	97	,,	Keswick, High Hill	4·21	...
,,	Cullompton	1·89	70	*Glam*	Cardiff, Ely P. Stn.	3·04	98
,,	Sidmouth, Sidmount	1·57	63	,,	Treherbert, Tynywaun	8·63	...
,,	Filleigh, Castle Hill	2·89	...	*Carm*	Carmarthen Friary	4·56	130
,,	Barnstaple N. Dev. Ath.	2·53	94	,,	Llanwrda	6·00	138
Corn	Redruth, Trewirgie	2·91	95	*Pemb*	Haverfordwest, School	...	...
,,	Penzance, Morrab Gdn.	3·01	111	*Card*	Aberystwyth	4·21	...
,,	St. Austell, Trevarna	3·62	108	,,	Cardigan, County Sch.	3·15	...
Soms	Chewton Mendip	3·61	103	*Brec*	Crickhowell, Talymaes	5·40	...
,,	Long Ashton	2·38	...	*Rad*	Birm W. W. Tyrmynydd	6·88	167
,,	Street, Millfield	1·77	...	*Mont*	Lake Vyrnwy	5·31	155
Glos.	Cirencester, Gwynfa	3·35	130	*Denb*	Llangynhafal	3·82	...
Here	Ross, Birchlea	3·05	134	*Mer*	Dolgelly, Bryntirion	7·36	173
,,	Ledbury, Underdown	3·05	135	*Carn*	Llandudno	1·78	74
Salop	Church Stretton	5·36	219	,,	Snowdon, L. Llydaw 9	.	...
,,	Shifnal, Hatton Grange	5·25	233	*Ang*	Holyhead, Salt Island	2·60	100
Worc	Ombersley, Holt Lock	3·06	146	,,	Lligwy	2·38	...
,,	Blockley	3·87	...	*Isle of Man*			
War	Farnborough	4·34	169		Douglas, Boro' Cem.	2·81	92
,,	Birminghm, Edgbaston	4·46	192	*Guernsey*			
Leics	Thornton Reservoir	5·38	217		St. Peter P't. Grange Rd.	2·27	112

Rainfall : July, 1930 : Scotland and Ireland

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent of Av.
Wigt.	Pt. William, Monreith	2·59	...	*Suth* .	Loch More, Achfary...	2·71	51
,, .	New Luce School......	2·19	...	*Caith* .	Wick.........	1·36	52
Kirk .	Carsphairn, Shiel.......	5·81	...	*Ork* .	Pomona, Deerness......	1·63	63
,, .	Dumfries, Cargen......	...	...	*Shet* .	Lerwick	2·51	109
Dumf.	Eskdalemuir Obs.......	5·61	137	*Cork* .	Caheragh Rectory......	3·52	...
Roxb .	Branxholm	5·10	169	,, .	Dunmanway Rectory...	3·76	96
Selk .	Ettrick Manse..........	4·58	...	,, .	Ballinacurra............	2·34	84
Peeb .	West Linton...........	3·18	...	,, .	Glanmire, Lota Lo......	2·28	75
Berk .	Marchmont House......	3·59	118	*Kerry*.	Valentia Obsy..........	4·11	109
Hadd.	North Berwick Res.....	4·01	155	,, .	Gearahameen............	5·80	...
Midl .	Edinburgh, Roy. Obs.	3·90	148	,, .	Killarney Asylum......	2·42	73
Ayr .	Kilmarnock, Agric. C.	2·50	80	,, .	Darrynane Abbey.......	2·36	62
,, .	Girvan, Pinmore..	3·48	95	*Wat* .	Waterford, Brook Lo...	3·03	93
Renf .	Glasgow, Queen's Pk. .	4·17	143	*Tip* .	Nenagh, Cas. Lough...	4·06	129
,, .	Greenock, Prospect H.	3·04	78	,, .	Roscrea, Timoney Park	3·26	...
Bute .	Rothesay, Ardencraig .	4·52	114	,, .	Cashel, Ballinamona...	3·47	120
,, .	Dougarie Lodge.........	2·60	...	*Lim* .	Foynes, Coolnanes......	2·98	97
Arg .	Ardgour House	3·39	...	,, .	Castleconnel Rec.......	3·92	...
,, .	Manse of Glenorchy...	4·13	...	*Clare* .	Inagh, Mount Callan...	5·53	...
,, .	Oban......................	2·86	...	,, .	Broadford, Hurdlest'n.	4·05	...
,, .	Poltalloch	3·27	79	*Wexf*.	Newtownbarry	...	...
,, .	Inveraray Castle...	6·30	127	,, .	Gorey, Courtown Ho...	2·99	102
,, .	Islay, Eallabus.........	3·14	92	*Kilk* .	Kilkenny Castle.........	3·08	109
,, .	Mull, Benmore.........	6·40	...	*Wic* .	Rathnew, Clonmannon	4·22	...
,, .	Tiree	...	...	*Carl* .	Hacketstown Rectory..	5·22	151
Kinr .	Loch Leven Sluice......	3·03	105	*Leix* .	Blandsfort House......	3·82	124
Perth .	Loch Dhu...............	5·05	104	,, .	Mountmellick...........	3·72	...
,, .	Balquhidder, Stronvar	3·43	...	*Off'ly* .	Birr Castle...............	3·14	106
,, .	Crieff, Strathearn Hyd.	2·84	96	*Dubl* .	Dublin, FitzWm. Sq...	2·61	102
,, .	Blair Castle Gardens...	1·77	69	,, .	Balbriggan, Ardgillan.	3·72	137
,, .	Glen Bruar, Bruar Ldg.	2·75	...	*Me'th* .	Beauparc, St. Cloud...	3·28	...
Angus.	Kettins School.	2·45	104	,, .	Kells, Headfort.........	4·15	130
,, .	Dundee, E. Necropolis	2·30	84	*W.M.*	Moate, Coolatore......	3·66	...
,, .	Pearsie House...........	2·75	...	,, .	Mullingar, Belvedere..	4·24	133
,, .	Montrose, Sunnyside...	1·89	72	*Long* .	Castle Forbes Gdns......	3·26	105
Aber .	Braemar, Bank...	2·89	112	*Gal* .	Ballynahinch Castle...	5·76	139
,, .	Logie Coldstone Sch....	2·16	73	,, .	Galway, Grammar Sch.	3·54	...
,, .	Aberdeen, King's Coll.	1·41	50	*Mayo* .	Mallaranny...............	6·66	...
,, .	Fyvie Castle.............	3·41	...	,, .	Westport House.........	4·36	141
Moray.	Gordon Castle...........	4·13	129	,, .	Delphi Lodge............	10·40	...
,, .	Grantown-on-Spey......	...	...	*Sligo* .	Markree Obsy...........	5·14	148
Nairn.	Nairn, Delnies	2·46	92	*Cav'n* .	Belturbet, Cloverhill...	3·86	124
Inv .	Kingussie, The Birches	2·84	...	*Ferm* .	Enniskillen, Portora...	...	...
,, .	Loch Quoich, Loan.....	3·87	...	*Arm* .	Armagh Obsy............	3·27	113
,, .	Glenquoich	3·39	53	*Down* .	Fofanny Reservoir......	8·46	...
,, .	Inverness, Culduthel R.	3·09	...	,, .	Seaforde..................	4·19	131
,, .	Arisaig, Faire-na-Squir	2·35	...	,, .	Donaghadee, C. Stn...	2·76	99
,, .	Fort William............	2·74	...	,, .	Banbridge, Milltown...	2·77	...
,, .	Skye, Dunvegan........	1·33	...	*Antr* .	Belfast, Cavehill Rd...	3·34	...
R & C.	Alness, Ardross Cas ...	2·59	85	,, .	Glenarm Castle.........	4·25	...
,, .	Ullapool	1·89	...	,, .	Ballymena, Harryville	4·11	120
,, .	Torridon, Bendamph...	1·95	36	*Lon* .	Londonderry, Creggan	4·37	119
,, .	Achnashellach...........	3·64	...	*Tyr* .	Donaghmore.............	5·44	...
,, .	Stornoway................	1·43	47	,, .	Omagh, Edenfel.........	3·75	110
Suth .	Lairg......................	2·09	...	*Don* .	Malin Head..............	3·04	...
,, .	Tongue....................	3·01	98	,, .	Dunfanaghy..............	2·66	...
,, .	Melvich..................	2·55	...	,, .	Killybegs, Rockmount.	4·71	107

Erratum : Castle Forbes Gdns., June, for 1·65/64 read 1·77/69.

Climatological Table for the British Empire, February, 1930.

STATIONS	PRESSURE: Mean of Day M.S.L.	PRESSURE: Diff. from Normal	TEMPERATURE: Absolute Max.	TEMPERATURE: Absolute Min.	TEMPERATURE: Mean Values Max.	TEMPERATURE: Mean Values Min.	TEMPERATURE: Mean Values ½ max. and min.	TEMPERATURE: Mean Values Diff. from Normal	TEMPERATURE: Mean Wet Bulb	Relative Humidity	Mean Cloud Am'nt	PRECIPITATION: Am'nt	PRECIPITATION: Diff. from Normal	PRECIPITATION: Days	BRIGHT SUNSHINE: Hours per day	BRIGHT SUNSHINE: Percentage of possible
	mb.	mb.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	%	0—10	in.	in.			
London, Kew Obsy.	1018·2	+ 2·2	51	29	42·6	35·1	38·9	— 1·2	35·1	83	8·1	0·58	— 0·96	5	1·7	18
Gibraltar	1018·0	— 2·0	69	40	60·6	46·0	53·3	— 2·6	45·7	82	4·0	6·52	+ 2·30	12	..	..
Malta	1014·6	— 2·1	64	45	58·2	50·0	54·1	— 1·2	49·6	78	6·2	5·19	+ 2·99	15	5·9	55
St. Helena	1012·1	+ 2·1	..	58	..	59·7	..	..	60·9	95	8·1	0·98	— 2·82	12	..	..
Sierra Leone	1012·0	+ 1·2	95	71	88·1	73·9	81·0	— 1·3	73·9	76	3·5	0·15	— 0·15	1	..	..
Lagos, Nigeria	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kaduna, Nigeria	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Zomba, Nyasaland	1010·2	+ 2·3	89	56	79·8	63·8	71·8	— 0·2	..	81	6·5	10·86	+ 0·21	15	..	..
Salisbury, Rhodesia	1008·9	+ 1·3	86	51	81·1	59·6	70·3	+ 1·5	61·7	61	4·3	1·43	— 5·97	8	8·8	69
Cape Town	1015·0	+ 1·6	93	50	80·6	60·3	70·5	+ 0·2	61·7	73	2·9	1·09	+ 0·51	5	..	..
Johannesburg	1013·0	+ 1·1	89	44	76·9	55·4	66·1	+ 0·7	57·1	68	4·6	3·97	— 1·25	13	9·2	71
Mauritius	1010·6	— 0·4	87	66	84·0	73·0	78·5	— 0·8	75·2	78	6·5	5·38	— 3·02	22	7·8	61
Bloemfontein	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calcutta, Alipore Obsy.	1014·5	+ 1·2	93	51	83·3	61·4	72·3	+ 1·3	61·0	81	2·3	0·77	— 0·33	1*	..	..
Bombay	1013·6	+ 0·9	94	59	85·5	66·3	75·9	+ 0·3	63·4	65	0·5	0·00	— 0·03	0*	..	..
Madras	1013·3	+ 0·4	91	63	85·4	70·0	77·7	0·0	72·7	83	3·8	2·21	+ 1·89	5*	..	..
Colombo, Ceylon	1012·2	+ 1·1	93	68	87·6	72·3	79·9	+ 0·2	74·6	70	3·7	1·97	— 0·10	7	9·9	83
Hongkong	1019·1	+ 0·4	78	47	65·0	56·5	60·7	+ 1·6	56·1	72	6·3	1·38	— 0·22	7	5·6	49
Sandakan	..	..	88	72	86·3	73·2	79·7	— 0·4	75·7	79	..	2·37	— 7·25	6	..	..
Sydney, N.S.W.	1016·9	+ 2·8	106	59	78·7	66·9	72·8	+ 1·5	68·2	69	5·5	0·61	— 3·63	8	8·4	63
Melbourne	1016·2	+ 1·7	103	51	82·5	59·4	70·9	+ 3·5	61·8	57	4·9	2·70	+ 0·98	8	7·4	55
Adelaide	1014·9	+ 0·6	112	52	92·8	66·2	79·5	+ 5·4	64·0	36	3·1	0·43	— 0·23	3	10·2	77
Perth, W. Australia	1013·8	+ 0·8	102	53	84·3	62·7	73·5	— 0·6	62·5	54	2·8	0·12	— 0·33	3	10·6	80
Coolgardie	1012·2	— 0·3	110	53	95·6	64·1	79·9	+ 3·9	62·3	43	3·0	0·75	0·00	3	..	..
Brisbane	1016·6	+ 4·1	92	63	82·7	67·5	75·1	— 1·4	68·9	67	6·7	1·81	— 4·38	13	7·7	60
Hobart, Tasmania	1015·2	+ 1·7	90	45	72·5	54·5	63·5	+ 1·1	56·2	61	5·7	1·23	— 0·22	6	8·1	59
Wellington, N.Z.	1018·3	+ 2·5	77	47	66·2	53·0	59·6	— 2·9	57·5	74	5·7	1·65	— 1·49	5	8·5	62
Suva, Fiji	1007·1	— 0·6	91	69	87·0	75·6	81·3	+ 0·8	76·8	78	6·0	19·91	+ 9·78	19	7·3	57
Apia, Samoa	1007·3	— 1·1	88	74	84·7	75·8	80·2	+ 1·2	77·8	82	6·0	18·93	+ 3·22	22	4·5	36
Kingston, Jamaica	1014·8	— 0·5	88	64	84·0	67·1	75·5	— 1·0	66·0	89	4·2	0·68	+ 0·08	6	6·8	59
Grenada, W.I.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Toronto	1016·9	— 1·1	55	— 6	34·1	19·5	26·8	+ 5·1	21·9	68	8·2	2·28	— 0·30	18	2·9	28
Winnipeg	1014·2	— 7·6	43	—29	18·9	5·4	12·1	+12·7	..	..	7·0	1·53	+ 0·69	10	3·2	32
St. John, N.B.	1015·6	+ 1·5	43	— 8	30·2	11·6	20·9	+ 1·0	16·9	75	6·0	4·54	+ 0·64	14	4·0	38
Victoria, B.C.	1014·7	— 1·2	54	33	46·8	37·5	42·1	+ 1·8	39·9	83	7·4	5·17	+ 1·64	21	3·1	30

* **For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.**

ERRATA—*Sierra Leone*, 1929. Pressure value at M.S.L and diff. from normal, January, *for* "1008·4, − 2·4" *read* "1011·8, + 1·0." Year *for* "1012·2, + 0·8" *read* "1012·5, + 1·1."
Lagos, 1929. " " " " October, *for* "1009·0, − 2·7" *read* "1010·6, − 1·1." Year *for* "1011·4, 0·0" *read* "1011·5 + 0·1."

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

ERRATA—*Sierra Leone*, 1929. Pressure value at M.S.L and diff. from normal, January, *for* "1008·4, −2·4" *read* "1011·8, +1·0." Year *for* "1012·2, +0·8" *read* "1012·5, +1·1."
Lagos, 1929 " " " " October, *for* "1009·0, −2·7" *read* "1010·6, −1·1." Year *for* "1011·4, 0·0" *read* "1011·5 +0·1."